Stenogyne kauaulaensis (Lamiaceae), a New Species from Maui, Hawaiian Islands

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ABSTRACT. *Stenogyne kauaulaensis* K. R. Wood & H. Oppenheimer (Lamiaceae), a narrow endemic from Kaua'ula, West Maui, Hawai'i, U.S.A., is described and illustrated. The new species differs from other known species of *Stenogyne* Bentham by its combination of flowers raised on a common peduncle, broadly campanulate calyx with large foliaceous teeth, strongly falcate corolla, and exserted stamens. Known from approximately 15 naturally occurring individuals, *S. kauaulaensis* easily falls into the Critically Endangered IUCN Red List category and is successfully cultivated for conservation.

Key words: Hawaiian Islands, IUCN Red List, Lamiaceae, *Stenogyne*, West Maui.

Stenogyne Bentham (Lamiaceae), as currently delimited, is a genus endemic to the Hawaiian Islands with primary diversity on the younger islands of Maui and Hawai'i (see Table 1). The endemic Hawaiian mints include two other genera, namely *Haplostachys* Hillebrand with five species restricted to the Hawaiian Islands, and *Phyllostegia* Bentham with 32 Hawaiian and two extra-Hawaiian species including one from Tahiti and one from Tonga (Wagner, 1999). *Phyllostegia* and *Haplostachys* are associated with insect pollination, being mostly white-flowered with a prominent lower lip and slight fragrance. *Stenogyne* is associated with flower visitation by honeycreepers, having representatives with falcate corolla tubes, abundant nectar production, and a variation of corolla colors including pink-red to deep purple (Weller & Sakai, 1990). Recent phylogenetic analyses of DNA sequence data indicate that the Hawaiian endemic mints derived from a single colonization event and are most closely related to North American *Stachys* L. from the Pacific coast (Lindqvist & Albert, 2002).

Sherff (1935) provided a preliminary revision of *Stenogyne* in which he recognized 24 species with numerous varieties. Subsequent studies of type specimens and recent publications (Weller & Sakai, 1990; Wagner & Weller, 1991, 1999) have revised species concepts in *Stenogyne*, recognizing 21 species and two subspecies. In the course of recent field research, a population of *Stenogyne* with unique floral characteristics was found in Kaua'ula, West Maui. Subsequent visits by the authors allowed for observation of the population during different phenological stages, and it became clear that this represented a previously undescribed species. This new discovery and description of *S. kauaulaensis* K. R. Wood & H. Oppenheimer brings the total number of *Stenogyne* species to 22.

Stenogyne kauaulaensis K. R. Wood & H. Oppenheimer, sp. nov. TYPE: U.S.A. Hawaiian Islands: West Maui, Lahaina Dist., SE slope of Kaua'ula Valley, 1025 m, 23 Jan. 2008, *H. Oppenheimer & J. Spencer H10817* (holotype, PTBG). Figure 1.

Haec species a congeneris floribus nonnullis pedunculo communi insidentibus, calyce late campanulato in dentes magnos foliaceos fisso, corolla valde falcata et staminibus exsertis differt.

Scandent or decumbent vines to several meters long; stems flexuous, spreading, 1–2.5 m, terete or weakly 4-angled, evenly pubescent to moderately tomentose, hairs spreading to slightly antrorse, occasionally glandular, young stems with pink- to purple-red tinge. Leaves light green, membranaceous, broadly ovate, blades 3.5–7(–9) × 2.5–4.7 cm, adaxially glabrate with sparse pubescence along midrib and veins, abaxially sparsely to densely pubescent, especially on midrib and veins, margins broadly crenate, occasionally crenate-denticulate, apex acute to attenuate, base cordate, rarely truncate, petioles 7–18 mm, densely pubescent, young growth with pink- to purple-red tinge. Flowers (5)6 per verticillaster, with (2)3 raised on peduncles (2–)5–9 mm, pubescent, bracts linear-filiform to subulate-filiform, often reflexed, ca. 6 × 1 mm, pubescent, pedicels (4–)7–11 mm, pubescent, occasionally glandular; calyx radially symmetrical,

Table 1. Checklist of *Stenogyne* species with island distribution, federal status (USFWS, 2003), and comparison of floral characters relative to *S. kauaulaensis* (Hillebrand, 1888; Sherff, 1935; Weller & Sakai, 1990; Wood & Oppenheimer, pers. obs.). Distribution abbreviations: H, Hawai'i (Big Island); K, Kaua'i; L, Lana'i; M, Maui; Mo, Moloka'i; O, O'ahu. Status abbreviations: C, Candidate for Listing; E, Endangered; EX, Presumed Extinct; SOC, Species of Concern. Symbols: +, present; −, absent.

Species	Island distribution	Federal status	Peduncle present	Calyx broadly campanulate	Corolla strongly falcate	Stamens exserted
Stenogyne angustifolia A. Gray	Mo (EX), M (EX), H	E	−	−	−	−
Stenogyne bifida Hillebrand	Mo	E	−	−	−	−
Stenogyne calaminthoides A. Gray	H		−	−	+	−
Stenogyne calycosa Sherff	M	SOC	−	−	+	−
Stenogyne campanulata Weller & A. K. Sakai	K	E	+	+	−	−
Stenogyne cinerea Hillebrand	M	SOC, EX	−	−	−	+
Stenogyne cranwelliae Sherff	H	C	−	−	−	−
Stenogyne haliakalae Wawra	M	SOC, EX	−	−	+	+
Stenogyne kaalae Wawra subsp. *kaalae*	O		+	−	−	−
Stenogyne kaalae Wawra subsp. *sherffii* (O. Degener) W. L. Wagner & Weller	O	SOC	+	−	−	−
Stenogyne kamehamehae Wawra	Mo, M		−	−	+	−
Stenogyne kanehoana O. Degener & Sherff	O	E	−	−	+	−
Stenogyne kauaulaensis K. R. Wood & H. Oppenheimer	M		+	+	+	+
Stenogyne kealiae Wawra	K	C	−	−	−	−
Stenogyne macrantha Bentham	H	SOC	−	−	+	−
Stenogyne microphylla Bentham	M, H		−	−	−	−
Stenogyne oxygona O. Degener & Sherff	H	SOC, EX	−	−	−	−
Stenogyne purpurea H. Mann	K		−	−	−	−
Stenogyne rotundifolia A. Gray	M		−	−	−	+
Stenogyne rugosa Bentham	M (EX), H		+	−	−	−
Stenogyne scrophularioides Bentham	H	SOC	−	−	+	−
Stenogyne sessilis Bentham	L (EX), M, H		−	−	−	−
Stenogyne viridis Hillebrand	M	SOC, EX	−	−	−	−

broadly campanulate, inflated in live material and well separated from base and tube of corolla, 17–24 mm, pubescent to glandular-pubescent, becoming glabrate in fruit, teeth lanceolate-deltate, foliaceous, 7–10 × 5–8 mm at base, with distinct midvein, apex acute to acuminate; corolla purple, pubescent externally with scattered longer glandular hairs, glabrate within, light green tinge clouded along inner throat, tube strongly falcate, 20–24 mm, upper lip entire, 7–9 mm, lower lip 3-lobed, 3–5 mm; stamens purple, exserted beyond upper corolla lip. Nutlets ca. 8 mm.

Distribution and habitat. *Stenogyne kauaulaensis* is a narrow endemic currently known from only the southeastern rim of Kaua'ula Valley, West Maui, in the Hawaiian Islands (Fig. 2). A total of 15 plants of the new species occur in a single population, where three clusters grow within 600 m of each other and range in elevation from 975 to 1075 m. *Stenogyne kauaulaensis* grows in a region characterized by steep to vertical rocky slopes and windward-facing ridges. The plant community represents a relictual native mesic shrubland and forest with canopy heights ranging from 2 to 5 m. Dominant tree genera include *Metrosideros* Banks ex Gaertner, *Coprosma* J. R. Forster & G. Forster, *Diospyros* L., *Dodonaea* Miller, *Kadua* Chamisso & Schlechtendal, *Melicope* J. R. Forster & G. Forster, *Myrsine* L., *Nestegis* Rafinesque, *Sophora* L., and *Wikstroemia* Endlicher. Other less common trees include *Ilex* L., *Leptecophylla* C. M. Weiller, *Pipturus* Weddell, *Pleomele* Salisbury, *Santalum* L., and *Zanthoxylum* L. Understory vegetation is comprised of native shrubs, vines, and herbs including *Achyranthes* L., *Alyxia* Banks ex R. Brown, *Cocculus* DC., *Dubautia* Gaudichaud, *Freycinetia* Gaudichaud, *Liparis* Richard, *Lipochaeta* DC., *Lysimachia* L., *Nerau-dia* Gaudichaud, *Remya* Hillebrand ex Bentham & Hooker f., *Smilax* L., and *Vaccinium* L., in addition to ferns such as *Cyrtomium* C. Presl, *Doodia* R. Brown, *Dryopteris* Adanson, *Lepisorus* (J. Smith) Ching, *Microlepia* C. Presl, *Nephrolepis* Schott, and *Pteris* L.

Conservation status and threats. *Stenogyne kauaulaensis* should be considered critically endangered

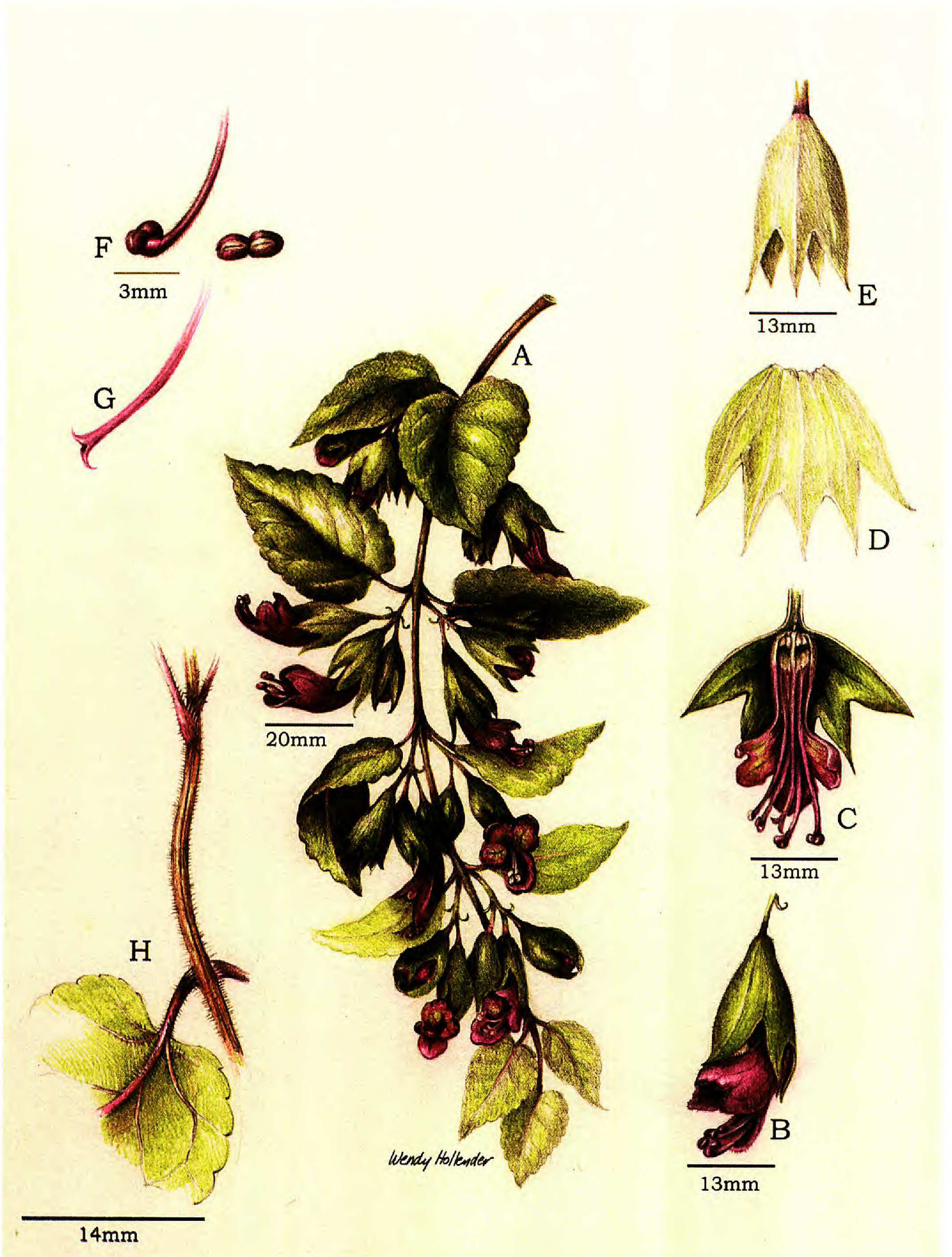

Figure 1. *Stenogyne kauaulaensis* K. R. Wood & H. Oppenheimer. —A. Flowering branch. —B. Single flower. —C. Longitudinal view of dissected corolla with stamens and pistil apparent. —D. Dissected calyx, interior. —E. Calyx. —F. Stamen with anther sacs. —G. Stigma and style. —H. Abaxial leaf surface and stem. Drawn from the paratype *Wood 12801* (PTBG).

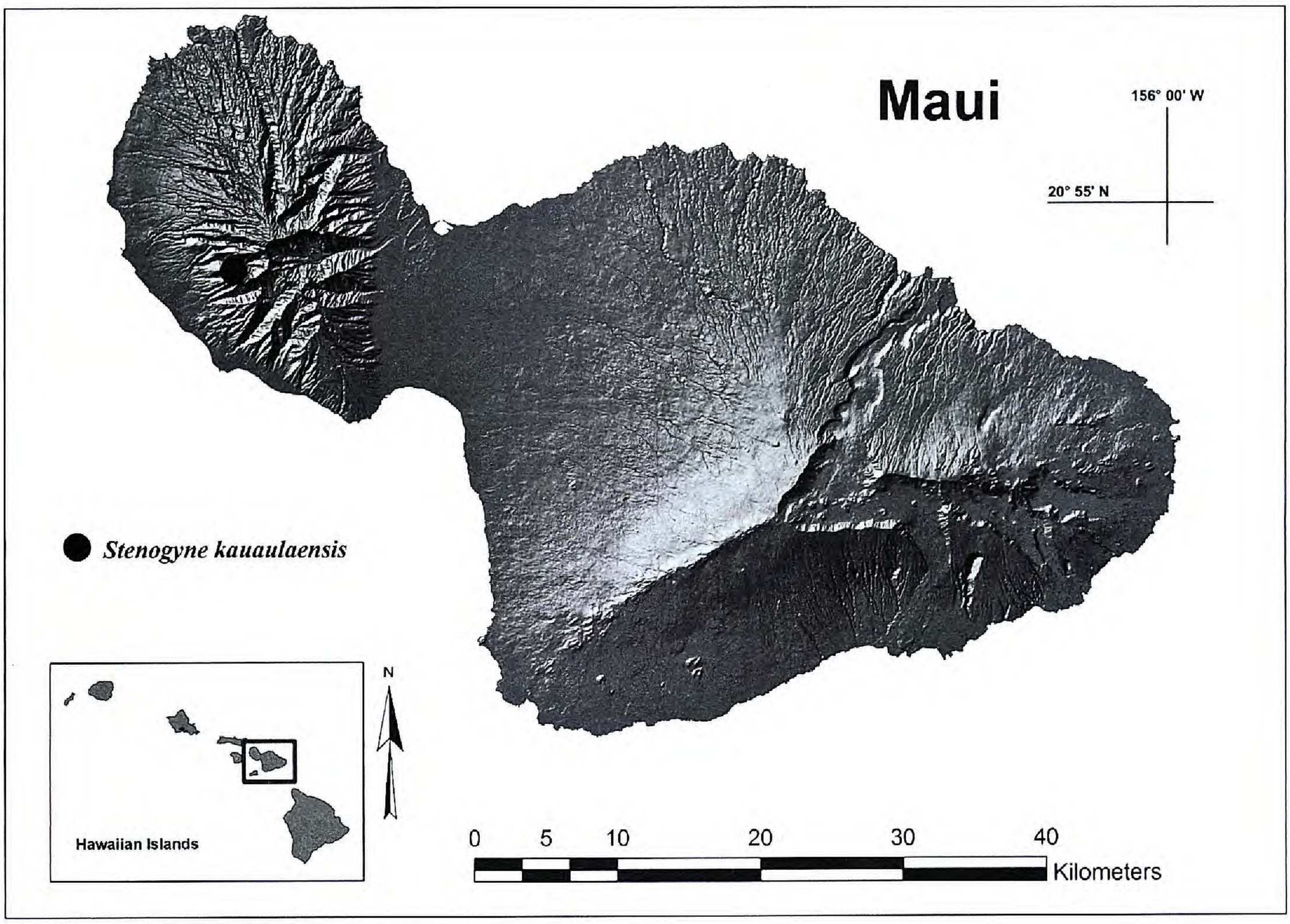

Figure 2. Location of *Stenogyne kauaulaensis* in Kaua'ula, West Maui, Hawai'i, U.S.A.

due to its limited range, low population numbers, probable loss of pollinators and/or dispersal agents, rockslides, herbivory by introduced slugs, and competition with non-native vegetation such as *Ageratina adenophora* (Sprengel) R. M. King & H. Robinson, *A. riparia* (Regel) R. M. King & H. Robinson, *Buddleja asiatica* Loureiro, and *Rubus rosifolius* Smith. Fire is also a serious threat to this ecosystem. In February 2007, a large brush fire in Kaua'ula Valley burned sections of nearby shrubland and came within 90 m of the two largest colonies of *S. kauaulaensis*. Early monitoring of successional vegetation has shown higher densities of fire-adapted, non-native grass species such as *Andropogon virginicus* L. and *Melinis minutiflora* P. Beauvois, raising the risk for future fire.

When evaluated using IUCN Red List criteria (IUCN, 2001), *Stenogyne kauaulaensis* falls into the Critically Endangered (CR) category, which designates this species facing the highest risk of extinction in the wild. *Stenogyne kauaulaensis* meets the IUCN criteria in having a range of less than 100 km^2, an area of occupancy of less than 10 km^2, presence in only a single location with a continuing decline inferred for the number of mature individuals, a continuing decline in the quality of habitat, and a population size of less than 50 mature individuals. Our formal evaluation can be summarized by the following IUCN hierarchical alphanumeric numbering system of criteria and subcriteria as CR B1ab(v)+2a-b(iii,v); D. *Stenogyne kauaulaensis* should also be listed by the U.S. Fish & Wildlife Service as Endangered under the Endangered Species Act of 1973, and a Recovery Plan should be written, funded, and implemented.

Cuttings collected from all three site locations of *Stenogyne kauaulaensis* are being successfully grown in Hawai'i at the National Tropical Botanical Garden, Lawa'i, Kaua'i; the Olinda Rare Plant Facility at Olinda, Maui; and Lyon Arboretum, Honolulu, O'ahu. Representative material of these ex situ plants is currently being grown and multiplied from stem cuttings and is slated to be out-planted in appropriate, secure habitat on West Maui.

Phenology. Flowering and fruiting of *Stenogyne kauaulaensis* have been observed between January and April.

Etymology. The new species is named for Kaua'ula Valley, a large amphitheater-shaped valley that cuts to the heart of the West Maui massif, where the holotype specimen was collected and the only known plants occur. Literally, kaua'ula means "the red rain" in Hawaiian (Pukui et al., 1974).

Affinities. *Stenogyne kauaulaensis* differs markedly from other known species of the genus by its combination of flowers raised on a common peduncle, a broadly campanulate calyx with large foliaceous teeth, strongly falcate corolla, and exserted stamens. Only three other species of *Stenogyne* share the character of flowers raised on a common peduncle, namely *S. campanulata* Weller & A. K. Sakai on Kaua'i, *S. kaalae* Wawra on O'ahu, and *S. rugosa* Bentham on both Maui and Hawai'i, yet none of these species has either falcate corolla tubes or exserted stamens, and only *S. campanulata* has a campanulate calyx. *Stenogyne campanulata* has other striking morphological differences from *S. kauaulaensis*, including densely tomentose leaves with serrate margins, a cream-yellow corolla tube with purple fringe along lips, and white stamen filaments.

Falcate corollas and exserted stamens represent a significant biological shift believed to be an adaptation toward bird pollination by honeycreepers, i.e., Drepanididae. Seven other species share the trait of falcate corolla tubes with *S. kauaulaensis*, yet none have a broadly campanulate calyx or, with the exception of *S. haliakalae* Wawra, have exserted stamens. *Stenogyne haliakalae*, one of four *Stenogyne* species considered extinct, also differs from *S. kauaulaensis* with its serrate leaf margins and bilabiate calyx with much smaller teeth (see Table 1 and the Key to the Maui species of *Stenogyne*, below).

The West Maui endemic *Stenogyne viridis* Hillebrand is comparable to *S. kauaulaensis* in having leaf margins broadly crenate, yet conspicuously differs in having only two flowers per verticillaster on short narrow pedicels and lacking peduncles. *Stenogyne viridis* is only known from the type collection made in 1870, *W. Hillebrand s.n.* (GH).

Paratypes. U.S.A. **Hawaiian Islands**: West Maui, Lahaina Dist., Kaua'ula Valley, SE rim on steep slopes, E colony, 20 June 2006, *K. R. Wood & H. Oppenheimer 11928* (PTBG), 24 Aug. 2006, *Wood & Oppenheimer 12096* (PTBG), 5 Dec. 2006, *Wood & Oppenheimer 12231* (PTBG); West Maui, Kaua'ula Valley, lower W colony, 24 Aug. 2006, *Wood & Oppenheimer 12099* (PTBG); East Maui, Olinda Rare Plant Nursery, cultivated from E colony, 8 Feb. 2008, *Oppenheimer & Hobdy H20801* (PTBG); Kaua'i, National Tropical Botanical Garden, Lawa'i Valley, cultivated from lower W colony, 15 Feb. 2008, *Wood 12801* (BISH, PTBG, US).

KEY TO THE MAUI SPECIES OF *STENOGYNE*

1a. Flowers raised on common peduncles. 2
1b. Flowers not raised on common peduncles 3
2a. Corolla tube strongly falcate; calyx broadly campanulate; flowers (5)6 per verticillaster; leaves with crenate margins, base cordate or rarely truncate . . . . . *S. kauaulaensis*
2b. Corolla tube straight; calyx weakly campanulate; flowers 2 to 16(to 24) per verticillaster; leaves with serrate margins, base acute, obtuse, truncate, or rarely somewhat cordate. . . . . *S. rugosa*
3a. Corolla tube (35–)45–56 mm long . . . . . *S. kamehamehae* Wawra
3b. Corolla tube 29 mm long or less 4
4a. Leaves 0.4–1.3(–2.7) cm long, margins crenate or lobed; calyx lobes obtuse or acute but not lanceolate; corolla tube greenish yellow, lobes brownish green to brownish pink. . . . . *S. microphylla* Bentham
4b. Leaves more than 1.5 cm long, margins crenate, serrate; calyx lobes acute or lanceolate in green-flowered species; corolla dark purple, red, pink, yellow, cream, green, or greenish yellow. 5
5a. Petioles absent or up to 4 mm in *S. sessilis* Bentham . . 6
5b. Petioles 4 mm long or more 7
6a. Stems terete, glabrous except at nodes; leaf margins broadly crenate; pedicels 8–9 mm long . . . . . *S. calycosa* Sherff
6b. Stems sharply or sometimes moderately 4-angled, glabrous or moderately to densely scabrous on stem ridges; leaf margins narrowly crenate or serrate; pedicels 3–8 mm long . . . . . *S. sessilis*
7a. Leaves narrowly ovate or elliptic to lanceolate or oblanceolate, ca. 4× as long as wide, glabrous . . . . . *S. angustifolia* A. Gray
7b. Leaves suborbicular, broadly ovate, or ovate to elliptic, occasionally lanceolate, less than 3× as long as wide, variously pubescent, hispid, or tomentose adaxially and/or abaxially, rarely glabrous. 8
8a. Corolla 12–17 mm long, tube straight; calyx teeth lanceolate, less than 5× as long as wide at base . . . 9
8b. Corolla 15–29 mm long (length unknown for *S. cinerea* Hillebrand), tube falcate; calyx teeth acute, or if lanceolate then 5× as long as wide at base . . .10
9a. Flowers 2 per verticillaster; leaves 1.5–3.9 cm long, margins broadly crenate . . . . . *S. viridis*
9b. Flowers 2 to 16(to 24) per verticillaster; leaves 3.7–10 cm long, margins serrate . . . . . *S. rugosa*
10a. Flowers 2 to 6 per verticillaster; calyx teeth lanceolate; leaves gray tomentose on both sides, margins crenate . . . . . *S. cinerea*
10b. Flowers 6(to 8) per verticillaster; calyx teeth acute; leaves glabrous or sparsely hispid to pubescent but not tomentose, margins serrate 11
11a. Leaves broadly ovate, adaxially pubescent or occasionally glabrous, abaxially densely pubescent, apex acute, base obtuse or truncate; pedicels densely to sparsely pubescent. . . . . *S. haliakalae*
11b. Leaves suborbicular, glabrous or sparsely hispid, apex obtuse or occasionally acute, base cordate or occasionally truncate; pedicels hispid . . . . . *S. rotundifolia* A. Gray

The following couplets can be seamlessly inserted into the existing key to the species of *Stenogyne* (Weller & Sakai, 1990: p. 833) to accommodate *S. kauaulaensis*.

7(6). Calyx broadly campanulate 7a
7. Calyx tubular 8
7a(7). Corolla cream-yellow, tube straight or nearly so; stamen filaments white and not exserted beyond upper lip; calyx teeth 1/2 as long as wide, sometimes barely evident; leaves densely tomentose, margins serrate; Kaua'i . . .*S. campanulata*

7a. Corolla purple, tube falcate; stamen filaments purple and exserted beyond upper lip; calyx teeth as long or longer than wide; leaves glabrate or pubescent, margins crenate; W Maui. . . . *S. kauaulaensis*

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